

CHILDREN'S COGNITIVE AND PSYCHOPHYSIOLOGICAL RESPONSES TO
AFFECTIVE PICTURES

By

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Emotional pictures reliably evoke a wide range of measurable physical reactions in adults. Changes in heart rate, skin conductance, and facial muscle activity are related to the affective content of the pictures. Additionally, unpleasant pictures facilitate the startle reflex while pleasant pictures inhibit it. This study looks at these response systems across a wide age range to determine whether the pattern of responses changes with age.

Thirty children (15 female) 7 - 10 years of age (median: 8 years), 30 adolescents (15 female) 12 - 15 years of age (median: 13 years), and 30 college undergraduates (15 female) 18 - 24 years of age (median: 19 years) participated in this study. Each participant viewed a series of pictures varying in affective content. Heart rate, skin conductance, and corrugator EMG were recorded during the 6 s picture period. During each picture, a 95 dB, 50 ms burst of white noise was delivered binaurally to elicit a startle eyeblink which was measured as EMG activity of the left orbicularis oculi.

Responses across the age groups were markedly similar. Heart rate change in children and adolescents showed the same pattern as previously seen in adults. Affective modulation of skin conductance and corrugator EMG were also similar to the pattern obtained for adults. Startle blinks were modulated by valence for undergraduates, but a more complex relationship between picture content and blink magnitude emerged for children and adolescents.

In a free viewing period, all age groups looked at pleasant and unpleasant pictures longer than neutral pictures. Adults and adolescents, however, looked at unpleasant pictures longer than both pleasant and neutral. An analysis of each age groups' ratings of the pictures reveals that all age groups rated the pictures similarly in pleasure, but young children rated the unpleasant slides less arousing than did adolescents or adults.

Taken together, these data indicate that children respond to affective pictures in ways very similar to adults. There were differences in picture preference, but the physiological response patterns for pleasant, neutral, and unpleasant pictures was consistent across age groups. Implications for the measurement of affective state in children is also discussed.

INTRODUCTION

Lang's (1985) bio-informational theory of emotion has been one of the most influential in the area of emotional development. Dodge (1989) states that since its first presentation, the bio-informational theory has had no serious competitors for the best explanation of emotional experience. Recent reviews (see Cuthbert & Melamed, 1993; Drobles & Lang, 1995) cover the bio-informational theory and its contributions to emotion research in more detail. Of relevance to the current discussion are the types of information that Lang states are intrinsic to the emotional experience: sensory input, semantic or linguistic constructs, and physical responses. The responses occurring to perceived environmental stimuli are fundamental in the experience of emotion and can be measured in three output systems: verbal, physiological, and behavioral responses.

Within the framework of the bio-informational theory, a number of studies (e.g., Bradley, Cuthbert, & Lang, 1990; Bradley, Lang, & Cuthbert, 1993; Cuthbert, Bradley, & Lang, in press; Lang, Greenwald, Bradley, & Hamm, 1993) have demonstrated that emotional pictures reliably evoke a wide range of measurable physical reactions in adults. By measuring responses in the three output systems described above, much has been learned about emotional response. Behavioral measures such as viewing time, and verbal report measures such as affective ratings, have been used in a picture viewing paradigm that uses a wide variety of standardized affective pictures to elicit emotional reactions. Physiological measures, including changes in heart rate, skin conductance, startle eyeblink magnitude, and facial muscle activity have

been shown to be reliably related to the affective content of pictures and to subjects' affective reports.

The purpose of this study is to increase our knowledge-base regarding children's and adolescents' physiological responses to affective stimuli by determining if the picture paradigm established by Lang and his colleagues is useful in the study of emotional states in these populations. Within this paradigm, affective pictures are used to elicit emotional states in the laboratory and responses are measured using physiological, self-report (i.e., ratings), and behavioral (i.e., viewing time) methods. This study seeks, within a bio-informational framework, to determine whether the pattern of responses across a variety of response systems to affective pictures changes as a function of age.

Organization of Emotions

Dodge (1989) points out that the organizational framework within which one works plays an important role in the conceptualization of research questions. While much of the work investigating the development of emotions is based on the expression of specific emotions (i.e., Ekman, 1984; Izard, 1977) or cognitive stage development (Case, Hayward, Lewis, & Hurst, 1988; Fischer, Shaver, & Carnochan, 1990; Harris, 1989; Harter & Buddin, 1987), these approaches tend to limit measurement to a single response system. The orientation of the present study is based on the work by Lang and his colleagues (Lang, 1995; Lang, Bradley, & Cuthbert, 1990; Lang et al., 1993). It is founded on a dimensional view, which assumes that emotion can be defined in terms of values on a limited number of independent dimensions that organize affective states. A dimensional organization reduces the vast array of emotional states into a set of values on the dimensions. Konorski (1967) developed a method of classifying emotional behavior based on the underlying motivational set of the organism. This method allowed a large set of emotions to be defined

in terms of two motivational dimensions: appetitive and aversive. In this work, Konorski (1967) initially organized mammalian behaviors into two major categories based on their biological role. One set of responses he termed preservative and included all activities involved in necessary intake of substances (e.g., food, air), excretion of waste, rest and recuperation, and procreation, etc. The second set of responses were called protective and included withdrawal from noxious or dangerous stimuli, rejection of harmful stimuli, and aggressive attack on dangerous enemies. Konorski describes the preservative responses directed toward a stimulus as appetitive and the stimuli that evoke these responses as attractive. The protective responses directed away from the stimulus are called defensive and the stimuli that evoke these responses are called aversive.

Further ideas regarding the organization of behavior into a biphasic motivational system come from Schneirla (1959). Arguing that approach and withdrawal behaviors were the only empirical, objective terms that could be applied to all motivated behavior in all animals, he proposed that all behavior could be described in these terms. Toward that end, approach is defined by Schneirla as getting nearer to the source of the stimulus, whereas withdrawal involves an increase in the distance between the organism and the source of the stimulus. The list of approach behaviors includes food-getting, shelter-getting, and mating. Withdrawal behaviors include defense, huddling, and flight. This biphasic organization provides a basic framework within which emotions can be understood in terms of dimensions.

Following the ideas of Konorski (1967) and Schneirla (1959), Lang and his colleagues have presented a theory of emotion based on the motivational states of the organism. According to this view, stimuli are organized as a function of their hedonic value to the organism. Appetitive stimuli are

associated with pleasant hedonic states in the organism and aversive stimuli associated with unpleasant states. This describes an approach/avoid dimension that corresponds to pleasure. The intensity of an emotional state is described in terms of arousal or activation of the organism. The advantage a dimensional organization offers over discrete emotional states is that the researcher does not have to determine specific behaviors that correspond with a given emotion on a one-to-one basis for measurement. The task of the researcher becomes one of describing the motivational state (appetite or aversion) of the organism. For example, spontaneous defecation, freezing, and flight are among the many behaviors classified as fear related. With such a diverse set of behaviors to code, it is difficult to determine the state of the organism at the time of measurement (Lang, 1995; Lang et al., 1990; Lang et al. 1993).

Fox (1991) has extended Lang's theory to include emotional development beginning in infancy. Using data from studies with infants, Fox proposes that there are a limited number of motivational situations for an infant. Emotional life for the infant, therefore, arises from these limited situations that can be aligned along the dimensions of approach and withdrawal. Increasing emotional complexity develops as a function of the blending of approach and withdrawal tendencies. Also, as motor skills develop, motor response patterns are added to the infants repertoire of emotional expression and facilitate approach and withdrawal. There is evidence from EEG studies (Fox, 1991; Fox & Davidson, 1988) of a neurological basis for a dimensional organization of emotion. Fox and his colleagues find that EEG and behavioral data show evidence for two independent motivational systems that direct approach or withdrawal behaviors. With development, these two system become recognized as the full spectrum of specific emotions humans report.

Measurement of Stimulus Dimensions

In order to determine whether the affective states elicited by pictures can be adequately described by a finite number of dimensions, it is important to investigate how particular stimuli are represented in the two-dimensional space. The International Affective Picture System (IAPS, Center for Study on Emotion and Attention, 1994) is a set of color pictures depicting a wide range of emotional scenes that currently has normative (college undergraduate) ratings of valence, arousal, and dominance for hundreds of different pictures. To explore the nature of this space, an ongoing series of studies is being conducted at the University of Florida. The Self-Assessment Manikin (SAM) affective rating system devised by Lang (1980) is used for ratings. In this system, a graphic figure depicting each dimension on a continuously varying scale is used to indicate emotional reactions. As can be seen in figure 1, SAM ranges from a smiling, happy figure to a frowning, unhappy figure when representing the valence dimension; similarly, SAM ranges from an excited, wide-eyed figure to a relaxed, sleepy figure for the arousal dimension. Dominance is represented by a small, submissive SAM at one end and a large, dominant SAM at the other end. In this version of SAM, the subject can place an 'X' over any of the 5 figures in each scale, or between any two figures.

Using SAM, hundreds of college undergraduates have rated over five hundred pictures in the IAPS. The pictures sample a wide range of emotional contents, including babies, opposite-sex nudes, romantic couples, sports events, food, nature scenes, household objects, snakes, spiders, guns, cemeteries, mutilated bodies, and more. Figure 2 shows each slide located in emotional space as defined by its mean valence and arousal rating. These stimuli evoke reactions across the entire range of each dimension: mean valence ratings for these slides range

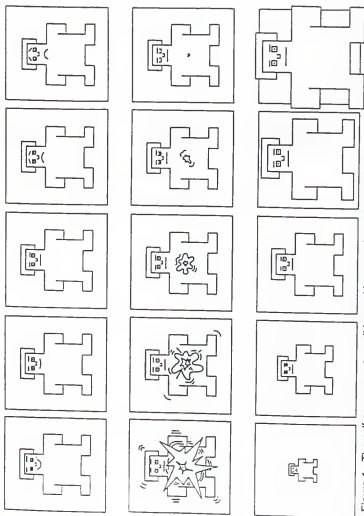


Figure 1. The self-assessment manikin used in normative rating studies.

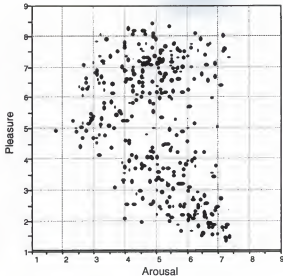


Figure 2. Pleasure and arousal ratings for the International Affective Picture System. These ratings come from several studies of college undergraduates' ratings of affective pictures.

from extremely unpleasant to extremely pleasant, and are distributed fairly evenly across the valence dimension. Also, a wide range of arousal levels are elicited by these materials (Bradley, Greenwald, & Hamm, 1993).

Not only has the SAM been shown to be able to represent the affective space described by slides, Bradley and Lang (1994) have shown that it is highly correlated with the Semantic Differential scale of Russell and Mehrabian. In a study comparing SAM ratings to Semantic Differential ratings, correlations between Semantic Differential scale, SAM ratings were computed. A factor analysis of the Semantic Differential scale produced results very close to those

of Mehrabian and Russell (1974), with three factors of pleasure, arousal, and dominance accounting for most of the variance. Each factor score was then averaged across subjects to produce a mean score on that factor for each slide. Pearson correlations between these computed factor scores and the mean SAM rating for the slides were very high.

The work done on the IAPS shows that a wide range of emotions, as elicited by visual stimuli, can be described in terms of valence, arousal, and dominance. It is understood that pictures may not be able to represent the full spectrum of emotions, but other studies using sounds and words confirm that emotional dimensions can adequately describe certain emotional experiences.

Children's Knowledge and Use of Emotional Dimensions

The studies described above provide strong evidence that the dimensions of pleasure and arousal can be used to describe emotional stimuli by adults. In order for a dimensional approach to the organization of emotion to be useful, however, it would be helpful if data indicated that emotional concepts of children are organized along dimensions comparable to adults. The following discussion presents strong evidence that children organize their emotional concepts in terms of valence and arousal.

One investigation of children's emotional concepts was conducted by Russell and Ridgeway (1983) using emotional adjectives. Teachers provided a list of words they considered to represent the emotional lexicon of children 11 to 14 years old. A questionnaire of 51 emotional words or phrases was created and 270 children rated how they felt that day. The children's answers were used in a principle components analysis. Two factors were retained, with the first factor accounting for 23.4 percent of the initial variance and the second accounting for 5.0 percent of the variance. The first factor was interpreted by the authors as a pleasure factor, with words like "nice" and "cheerful" loading

positively and "miserable" loading negatively. The second factor was an arousal factor with words like "sleepy" on the negative end and "full of energy" at the positive end.

Further evidence that children's emotional concepts can be defined as a function of two dimensions comes from Russell and Bullock (1985). A sorting task was assigned to 30 college undergraduates and 42 preschoolers four to five years of age. The task involved sorting pictures of facial expressions into two piles of similar emotional expression. This task was repeated for 3, 4, 7, and 10 piles. Children's groupings and the dimensional structure of the groupings showed a remarkable similarity to that of adults. Multi-dimensional scaling generated a two dimensional model (pleasure and arousal) that accounted for the groupings. Furthermore, correlations between the children and adults were greater than .90 for both of the dimensions. Another study by Russell and Bullock (1986) replicated these findings and extended them to include 2-year-olds. The results here show that even very young children organize their interpretation of emotional facial expressions in terms of a biphasic dimensional model of emotions.

The research of Russell and his colleagues shows that children's emotional concepts can be described in terms of the primary dimensions of pleasure and arousal. This is supported by a study where adults were asked to rate drawings of emotional expressions made by children (Moland & Whissell, 1993). Children in grades 2, 4, and 7 produced drawings of several emotions: Happy, sad, angry, afraid, surprised, and disgusted faces were drawn. Adults were asked to label the drawings made by the children using the emotion words provided and also to rate them on the dimensions of pleasure and arousal.

An analysis of the categorization and dimensional ratings showed a great deal of similarity in the different ratings. The dimensional ratings made by

the adults strongly predicted their category placement. Both categorical and dimensional ratings were accurate, but interestingly, the dimensional ratings of fear and disgust better differentiated the two facial expressions than did the category assignment. This again illustrates that children's emotional concepts are not independent of the primary emotional dimensions of pleasure and arousal.

Direct Measure of Children's Use of Emotional Dimensions

To aid in selecting stimuli for the research presented here, a developmental study of pleasure and arousal ratings of emotional pictures was conducted. In this normative study, we used 60 of the IAPS pictures and obtained ratings of emotional responses from a sample of children and adolescents. Pictures depicting various emotional scenes were shown to 123 elementary and middle school students and 20 college undergraduates. Each subject rated the pool of pictures using the SAM. For pleasure, words like "happy", "good", and "unhappy", "bad", or sad" were used in the instructions to describe the endpoints. For arousal, words like "calm", "bored", and "excited", "nervous", or "wide awake" described the endpoints. Appendix A gives the complete instructions read to the children.

As can be seen in figure 3, children showed a consistent pattern of higher arousal pictures being rated as more extreme on the pleasure dimension. That is, pictures rated highly arousing were also rated as more pleasant or more unpleasant than pictures rated low in arousal. This pattern is identical to that found previously with adults. There were significant correlations between the child and adolescent groups ratings on both pleasure and arousal dimensions and ratings from the adult undergraduate sample on these dimensions. Specifically, correlations between young children and undergraduates were .95 and .88 for pleasure and arousal, respectively.

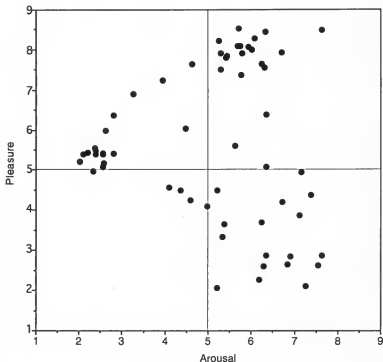


Figure 3. Normative ratings of affective slides for children 7 to 15 years of age.

Similarly high correlations were obtained between older children and undergraduates (.96 for pleasure and .89 for arousal) and for adolescents and undergraduates (.96 for pleasure and .90 for arousal).

Results indicate a high degree of reliability (Cronbach's α ranging from .97 to .99 for the sample) in children's ratings of emotional pictures. It is also clear that children verbal responses to emotionally evocative pictures are

similar to adults and that the Self-Assessment Mannequin is a useful measure of children's verbal responses to pictures.

Physiological Response Patterns to Affective Stimuli

As pointed out earlier, bio-informational theory describes emotional responding in terms of three output systems. Given that the verbal response system shows similarity in children's and adults responses to affective pictures, the next step is to investigate the physiological response system. There are a number of consistent physiological changes associated with emotional states and for most adults and children measurement of changes in heart rate, skin conductance, and facial muscle activity have been a reliable indicator of change in emotional state.

Physiological responses have been used in clinical research to assess fear and anxiety. In adults, heart rate acceleration and increases in skin conductance are associated with high fear states, such as phobia. For example, Cook, Melamed, Cuthbert, McNeil, and Lang (1988) found that phobic patients showed significant increases in heart rate and skin conductance when imagining scenes related to their specific phobia.

This response pattern can be found in children, as well. In one study of 60 asthmatic children between 10 and 15 years old, significant heart rate increases were found for both fear- and anger-related imagery. Children did not show heart rate increases when imagining neutral scenes (Tal & Miklich, 1976). Melamed, Yurcheson, Fleece, Hutcherson, and Hawes (1978) found that skin conductance increase during viewing of a video of a dental exam was related to reported dental fears. These studies demonstrate that physiological measures can index fear in adults and children.

A study of the relationship between physiological responses and the emotional dimensions of valence and arousal for adults can be found in Lang et

al. (1993). Participants saw a series of color pictures while a variety of responses were collected, sampling from all three response systems. Heart rate, skin conductance, and corrugator and zygomatic EMG were all recorded. Viewing time, interest ratings, and SAM ratings of pleasure and arousal were also collected. Lang et al. found that corrugator EMG, zygomatic EMG, and heart rate acceleration were all highly correlated with ratings of pleasure. It is important to note here that, contrary to the clinical findings, unpleasant pictures did not generate heart rate acceleration; rather, they generated strong deceleration. This difference may be due to the fact that the pictures did not include stimuli that were particularly relevant to specific fears of the participants, as in the clinical studies. The two states may, therefore, have been qualitatively different with clinically relevant stimuli provoking the defensive response associated with high heart rate acceleration, and the nonclinical sample showing greater orienting to the unpleasant pictures.

Skin conductance, on the other hand, was highly correlated with rated arousal for both pleasant and unpleasant slides. Further, when the physiology measures were combined with the ratings and viewing time measures in a principal components analysis, two factors, accounting for 76 percent of the variance, were derived. The first factor included pleasure ratings, corrugator EMG, heart rate acceleration, and zygomatic EMG as variables with high factor loadings. Arousal ratings, interest ratings, viewing time, and skin conductance loaded onto factor 2.

These loadings support the findings of Greenwald, Cook, and Lang (1989) and suggest that the dimensions of pleasure and arousal can adequately describe the physiological responses to affective pictures. These studies also show that facial muscle activity, heart rate, and skin conductance are reliable measures of affective responses in the human.

Lang and his colleagues have also developed a methodology for probing the emotional state of an individual at a discrete point in time (see Lang et al., 1990). As described by Konorski (1967), an intense stimulus with rapid onset (startle stimulus) elicits a defensive reaction. In the context of the present work, this defensive reflex is facilitated or diminished, depending on the affective context in which the reflex is elicited. When a foreground stimulus is unpleasant, matching the valence of the elicited startle, the startle is enhanced. The converse is also true. If a subject views a pleasant picture, an elicited startle is smaller than if the subject were viewing a unpleasant picture. By using a startle probe to elicit an eyeblink, a person's motivational state can be assessed.

Affective Modulation of the Human Startle Eyeblink

The startle probe is a physiological measure that has been particularly useful in identifying the emotional state of individuals in the laboratory. A startle probe, delivered during the processing of emotional material, elicits an eyeblink that is modulated by the affective valence of the material being processed. Specifically, an elicited eyeblink during the processing of unpleasant stimuli is larger than an eyeblink elicited during exposure to pleasant stimuli.

An early study investigating the emotional modulation of the startle response in adult humans was conducted by Vrana, Spence, and Lang (1988). The authors predicted that unpleasant emotions would potentiate the startle response and pleasant emotions would inhibit the startle response. The methodology used in this study involved the presentation of slides varying in emotional valence. Slides were chosen to represent a range of pleasant, neutral, and unpleasant scenes. As hypothesized, startle magnitude was smallest for pleasant slides, larger for neutral slides, and largest for negative slides. More recent studies have shown that the affective modulation of the

startle response is a robust phenomenon that is maintained as the startle reflex habituates (Bradley, Lang, & Cuthbert, 1993) and can be used to explore the time course in the development of emotional responses to slides (Bradley, Cuthbert, & Lang, 1993).

A recent study extended the study of affective modulation of the startle response to infants. Balaban (1995) used a picture methodology with 18 infants (20 weeks old). In her study, pleasant, neutral, and unpleasant slides were smiling, neutral, and angry adult faces, respectively. The startle probe was a 95 dB, 75 ms burst of white noise. Startle eyeblinks were scored off-line from EMG activity of the orbicularis oculi. Scoring of eyeblinks quantified the size of the blink and the latency of the reflex from probe onset. Infant facial expressions, tongue protrusions, and motor activity were also coded. A supplemental group of seven infants were run in a similar procedure, but saw only pleasant and unpleasant faces.

The finding most relevant to the present study is that the magnitude of the eyeblink reflex was the best measure of whether the infant was looking at a pleasant, neutral, or unpleasant facial expression. Startle eyeblink magnitude showed a strong linear relationship to pictured facial expression with 15 of the original 18 infants showing larger startles to angry faces relative to smiling faces. This pattern of startle modulation was true for the supplemental group, also. None of the behavioral measures showed a significant relationship to the valence of the picture. Results of this study reveal that infants, like adults, display a significant linear trend in eyeblink magnitude with pleasant slides inhibiting startles and unpleasant slides facilitating startles. Also, given that the modulation of the startle response was the only measure that reliably differentiated picture valence, it may be more sensitive to affective state than the behavioral measures that were included in this study.

Research Questions

The present study investigates the pattern of responses, using a bio-informational approach, in children and adolescents and the extent to which these patterns are similar to the pattern seen in college undergraduates. The primary aim of the present study is to determine if the picture viewing paradigm, with its measures of verbal, behavioral, and physiological responses to emotional stimuli, is one that can be used with children and adolescents. The pattern of responses seen in undergraduate populations is well understood, so if the same paradigm can be adapted for use with younger populations, then what is known about adult responses can aid in the interpretation of results from studies with children.

Affective judgments provide the basis for the analyses. Evidence from the normative study shows that children's concept of pleasure and arousal, as represented by SAM, is similar. The picture stimuli were selected to maximize children's responses, but all age groups are expected to rate them similarly. Participants judgments will be used to determine a progression along the valence and arousal dimensions. The covariation between the cognitive response system (affective judgments) and the physiological response system will be tested using correlation and regression coefficients. Specifically, from Lang et al. (1993), it is expected that pleasure ratings will be negatively related to corrugator muscle activity and startle magnitude and positively related to heart rate deceleration. Arousal ratings, on the other hand, are expected to correspond with skin conductance.

Specific questions regarding how children and adolescents respond to stimuli within a specific valence category include whether they demonstrate increased activity of the corrugator muscle when viewing unpleasant material; whether the younger participants exhibit heart rate acceleration to unpleasant

material, or an orienting response, as seen in young adults; and if skin conductance responses of younger subjects are similar to those seen in college undergraduates.

Given the similarity in facial expressions across age groups, it is expected that children and adolescents will display greater corrugator muscle EMG when viewing unpleasant pictures, relative to pleasant pictures. Previous studies have demonstrated that children and adolescents show heart rate changes comparable to those of adults in emotional settings. Children and adolescents are expected, therefore, to show greater heart rate deceleration when viewing unpleasant pictures relative to pleasant and neutral pictures. Skin conductance is expected to vary with arousal. That is, high arousal slides, regardless of valence, are hypothesized to be related to higher levels of skin conductance in children and adolescents, as with adults. All of these relationships are expected to hold for all age groups. Also, affective modulation of the startle response has been demonstrated in adult and infant populations, it is hypothesized that children and adolescents will show facilitation of the startle reflex when elicited while viewing unpleasant pictures, relative to responses while viewing pleasant pictures.

Changes in the level of arousal for pictures are hypothesized to be reflected in changes in skin conductance, orbicularis oculi, and viewing time. As seen previously in studies using young adults (Greenwald et al., 1989; Lang et al., 1993), increases in skin conductance should be related to increases in rated arousal. This relationship is also hypothesized for orbicularis oculi EMG and viewing time measures. The outcome of this study, then, is expected to be a variety of measures related to the affective dimensions of pleasure and arousal. Developmental differences in these measures and their relationship to affective dimensions will be explored.

METHOD

Subjects

Thirty children (15 female, 15 male) seven to ten years of age, 30 adolescents (15 male, 15 female) 12 to 15 years of age, and 30 undergraduates (15 female, 15 male) from the University of Florida participated in this study. Children and adolescents were recruited from Alachua County, Florida, through a random sample of names drawn from the school district rolls. These children received 10 dollars for their participation. The undergraduates were students in an Introductory Psychology course who fulfilled a class requirement for their participation. One subject, a seven-year-old male, withdrew from the experiment saying he was bored. One seven-year-old male was dropped from the final analysis because he did not stay on task, as determined by observation.

Apparatus and Response Measurement

The timing, stimulus control, and data acquisition of experimental events was controlled by a Northgate 486 computer. Slide duration was controlled by a Gerbrands electronic shutter. Slides were projected onto a white matte screen approximately 2 m. in front of the participants by a Kodak Ektagraphic III slide projector. Startle stimuli were 95 dB bursts (50 ms) of white noise produced by a Coulbourn Noise Generator and presented binaurally through headphones. The noise was calibrated using a Quest model 1700 precision impulse sound level meter.

The startle eyeblink reflex was measured by recording electromyographic (EMG) activity over the orbicularis oculi region under the left

eye with Sensor Medic miniature Ag/AgCl surface electrodes (see Lang et al., 1990). The raw EMG signal was amplified ($\times 30000$) using a Coulbourn Bioamplifier, and bandpass filtered with a low cutoff of 90 Hz and a high cutoff of 250 Hz and digitally sampled at 20 Hertz (Hz) until a startle probe was delivered. The amplified and filtered signal was rectified and integrated using a Coulbourn Contour-Following Integrator with a time constant of 125 ms. This signal was digitally sampled at 1000 Hz from 50 ms before startle probe onset until 250 ms after probe onset.

Corrugator activity was measured by recording EMG activity over the left corrugator muscle region with Sensor Medics miniature Ag/AgCl surface electrodes filled with electrolyte. The raw EMG signal was amplified ($\times 30,000$) using a Coulbourn Bioamplifier, and bandpass filtered with a low cutoff of 90 Hz and a high cutoff of 1000 Hz. The amplified and filtered signal was rectified and integrated using a Coulbourn Contour-Following Integrator with a time constant of 500 ms.

Heart rate was measured from sensors attached to the left forearm and right collarbone of participants, amplified by a Coulbourn amplifier. The output of the amplifier was fed into a Schmidt trigger which detected R-waves and sent a signal to the Northgate computer. Interbeat intervals were recorded as the time between R-waves to the nearest millisecond. Heart rate was then calculated off-line following Graham (1980).

Skin conductance was transduced with Sensor Medic standard electrodes filled with a .05 Molar Unibase cream electrolyte (Fowles, Christie, Edelberg, Grings, Lykken, & Venables, 1981) affixed to the hypothenar eminence of the left palm. A Coulbourn skin conductance coupler maintained a constant voltage (.5 volts) across electrodes. The analog signal was digitally sampled at 20 Hz.

Viewing time was counted to the nearest millisecond and recorded by an IBM XT computer. The same computer presented the Self-Assessment Manikin (Lang, 1980) and recorded valence, arousal, and dominance ratings. Ratings were on a scale from 0 to 20 and a joystick was used to manipulate the SAM figure.

Stimulus Materials

Stimuli were selected from a set of 60 pictures previously rated on the dimensions of pleasure, arousal, and dominance. Stimuli were selected on the basis of their overall ratings, across age groups, in order to find a set of stimuli that would provoke strong emotions in all age groups. Twenty-seven of the original pictures were selected, nine that were high on both pleasure and arousal (pleasant), nine that were low on pleasure, but high on arousal (unpleasant), and nine that were in the center of the pleasure scale and low in arousal (neutral). All pictures were within ethical standards for eliciting emotion in children. Figures 4, 5, and 6 show the normative ratings for the slides used in the present study for children, adolescents, and adults, respectively.

Procedure

Participants came to the laboratory and were seated in a comfortable waiting room where the procedure was explained and informed consent obtained. For children, the procedure was explained to them while their parent was present. After obtaining informed consent from subjects and their parents (for children and adolescents), participants were led into a small (3.0 x 2.4 m) sound-attenuated room and seated in a reclining chair. Skin conductance sensors were placed on the palm of the left hand of the participant after cleaning the palm with water. The left forearm and right collarbone were prepared by scrubbing the sites with an alcohol pad, and then the heart rate sensors were attached. Corrugator and orbicularis oculi sites were prepared

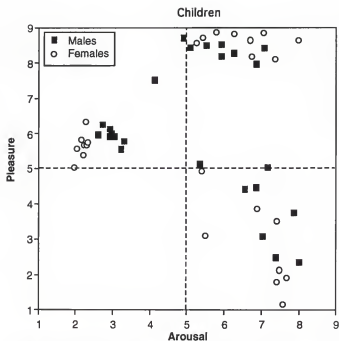


Figure 4. Children's pleasure and arousal ratings of affective pictures in the normative study

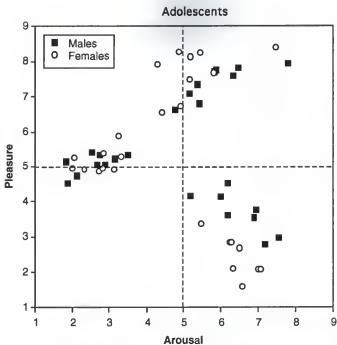


Figure 5. Adolescents' pleasure and arousal ratings of affective pictures in the normative study.

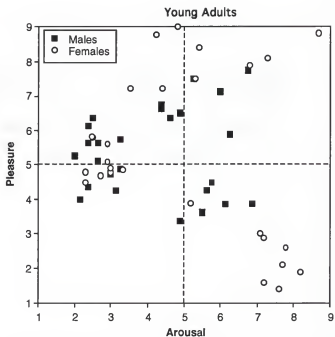


Figure 6. Young adults' pleasure and arousal ratings of affective pictures in the normative study.

with Omniprep and the sensors were then attached. Finally, headphones were placed on the participants. Parents were allowed in the room during this part of the procedure if the child or parent requested.

The lights were dimmed and participants were instructed to watch the slides the entire time they were on the screen (6 s) and to keep their movements to a minimum. Parents, if present, were then asked to return to the waiting room. The experimenter left the room and subjects were given two minutes to adjust to the new light level before the first slide was presented. Each participant saw 27 slides in one of three possible slide orders. Orders were randomly generated with the constraints that each of three groups of nine slides (one third) was presented in the first, second, and last block across the three orders, and each group of three slides (nine groups) contained a pleasant, unpleasant, and neutral slide. Data collection began six seconds before slide onset and continued for six seconds after slide offset. The amount of time between slides varied from 12 to 30 seconds. A startle probe was delivered randomly between 2.8 and 5.5 seconds into the slide viewing period of each slide. There were also six startle probes delivered between slides, the first one delivered before the first slide was presented.

Following the picture trials, the sensors were removed and the participants were given an opportunity to stretch. Older participants, adolescents and undergraduates also completed the EASI temperament questionnaire at this time. This questionnaire was filled out by the parents of the young children.

Participants were then instructed on how to use a joystick to control the amount of time they viewed a slide, and the SAM rating procedure (see Appendix B for specific instructions given). There were two neutral practice slides presented to ensure that each participant understood that he or she could

view each slide for as long as he or she wished (up to 30s maximum) before making his or her ratings. The slides were then presented in the same order as before, and pleasure, arousal, and dominance ratings (always in that order) were made for each slide. At the end of the procedure, participants were debriefed and received their compensation.

Physiological Data Reduction and Analysis

Average values for each half-second of data collection were computed. EMG activity during slide viewing was converted to change from baseline scores. Pictures were ordered by increasing ratings on pleasure and arousal and a subjects were averaged within ranks across physiological measure to produce an average response at each level of pleasure and arousal. Also, an average over the entire slide viewing period was obtained and then the data were averaged within subject over all slides of a given valence. The result was a mean EMG activity during the six second slide period for each valence category for each subject. Heart rate change from baseline was computed in the same manner as corrugator, as was skin conductance.

Startle responses were scored off-line for magnitude of change from baseline, latency from probe to the beginning of the eyeblink response, latency from the beginning of the response to the peak of the response, and the baseline orbicularis oculi activity before the probe was delivered.

RESULTS

Affective Ratings

Comparison Between Normative and Laboratory Results

Figures 7, 8, and 9 show the location of each slide in the space defined by pleasure and arousal ratings in the present study for children, adolescents, and adults, respectively. Dominance, as found previously in children and adults, was highly correlated with pleasure ($r=.91$; $p<.01$) and did not account for a significant amount of variance independent of pleasure ratings. Therefore, dominance is not included in the present discussion. The IAPS slides used in this study, their description, normative ratings, and the ratings from the present study are listed in appendix C.

Looking at the graphic representation of the affective space filled by the pictures used in this study and comparing them to normative ratings of the same pictures (see figures 4, 5, and 6 for children, adolescents, and adults, respectively) it is clear that the location in affective space did not remain stable, particularly for the youngest age group. Keeping in mind that the normative ratings had a scale of 1 to 9 and the laboratory ratings are on a scale from 0 to 20, it appears that young children did not find the unpleasant pictures as arousing as their peers who were used in the normative study. This is confirmed by looking at the correlations. Notice in table 1 that all the correlations between normative and laboratory pleasure ratings are above .90, but the correlations between normative and laboratory arousal ratings drops below .80 for female children and down to .50 for male children.

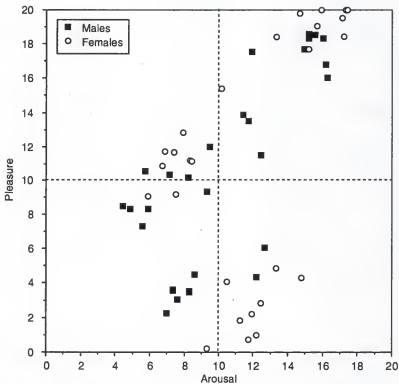


Figure 7. Children's pleasure and arousal ratings of affective pictures in the laboratory.

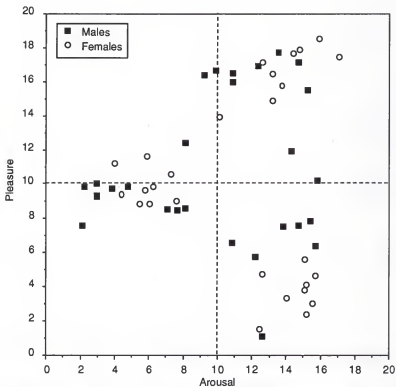


Figure 8. Adolescents' pleasure and arousal ratings of affective pictures in the laboratory.

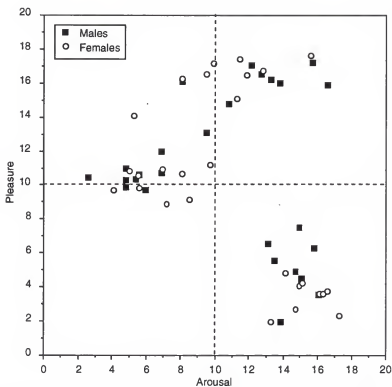


Figure 9. Young adult's pleasure and arousal ratings of affective pictures in the laboratory.

Table 1. Correlations between normative and laboratory settings for rated pleasure and arousal.

<u>Group</u>	<u>Pleasure</u>		<u>Arousal</u>	
	<u>Males</u>	<u>Females</u>	<u>Males</u>	<u>Females</u>
Children	.93	.98	.50	.79
Adolescents	.91	.99	.94	.93
Adults	.91	.96	.86	.91

Table 2. Correlations between Pleasure and Arousal Ratings in the Normative Study and the Laboratory Study.

<u>Group</u>	<u>Normative</u>		<u>Laboratory</u>	
	<u>Males</u>	<u>Females</u>	<u>Males</u>	<u>Females</u>
Children	-.26	-.07	.73***	.44*
Adolescents	.04	-.24	.20	.01
Adults	.08	-.23	-.14	-.44*

Note: * $p < .05$; *** $p < .001$

Analysis of Laboratory Ratings

Pleasure ratings. Table 3 shows that females consistently rated unpleasant pictures more aversive than did males across age groups, resulting in a significant interaction between gender and valence in pleasure ratings, $F(2, 83) = 7.97$; $p < .001$, in the overall, with post hoc analyses confirming that females rated unpleasant pictures as less pleasant than males. Differences in the way different age groups rated the pictures, $F(2, 83) = 5.22$; $p < .001$, may reflect some age related biases in specific preferences of items and events depicted in the pictures. Post hoc analyses, with Bonferoni corrections for multiple comparisons, confirmed that children rated the pleasant slides as more

pleasant than adolescents and adults. Also, for neutral pictures, adolescents rated them as less pleasant than did adults, but not children. For unpleasant pictures, there were no age differences.

Table 3. Mean pleasure ratings for each valence category of affective pictures for males and females participating in the present study.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	17.30	9.90	5.57	19.21	11.44	2.74
Adolescents	16.18	9.09	7.98	16.64	9.87	3.96
Adults	15.87	10.56	5.38	16.04	10.50	3.63
Totals	16.45	9.85	6.31	17.29	10.60	3.44

Arousal ratings. Looking at arousal ratings within each valence category, there was a difference in the way males and females rated arousal, $F(1, 84) = 4.52$; $p < .04$. Females rated all valence categories higher in arousal than males. Table 4 gives the means for each valence category by age group and gender. Notice that both males and females in the youngest age group rated unpleasant pictures less arousing than adults or adolescents.

Mean arousal ratings for each valence category demonstrated the same relationships as did the dimensional correlations. That is, children's arousal ratings were different than adult's and adolescent's. Figure 10 gives each age levels' mean arousal rating for each valence category. There was an interaction between age and picture valence, $F(4, 166) = 6.94$; $p < .01$. Post hoc analyses revealed no differences between adults and adolescents, and children different from both at each valence category.

Table 4. Mean arousal ratings for each valence category of affective pictures for males and females participating the present study.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	14.74	7.02	9.77	15.99	7.69	12.28
Adolescents	11.67	4.63	14.12	13.90	5.86	14.81
Adults	12.63	5.30	14.78	11.16	6.25	15.66
Totals	13.01	5.65	12.89	13.68	6.60	14.25

Relationship between pleasure and arousal ratings. Previous studies with college undergraduates have show the pleasure and arousal dimensions to be orthogonal (Lang & Greenwald, 1988; Lang, Greenwald, & Bradley, 1988; Lang, Greenwald, & Bradley, 1990). This was true for younger populations, as well, in the normative study. Looking back at table 2, the correlation between pleasure and arousal was not significant for any group in the normative study, but both male and female children show a significant positive correlation between pleasure and arousal ratings in the laboratory. This means that pleasant pictures were rated more arousing than unpleasant pictures for children, but the opposite relationship holds for young female adults. The strong positive correlation between pleasure and arousal indicates that children considered the unpleasant pictures as unpleasant, but did not find them arousing. Figure 7 shows that male children only rated two unpleasant pictures as both unpleasant (pleasure < 10) and arousing (arousal > 10). Looking at figure 9, young women rated all of the unpleasant slides as unpleasant and arousing.

Children's pleasure and arousal ratings. Comparing the relationship between arousal and valence category across the laboratory and normative

settings, the difference in children's ratings becomes even more clear. Looking at table 5 for the normative ratings, there is a clear pattern of rating unpleasant slides more arousing than pleasant slides. This is true for all age and gender groups. However, in the laboratory setting, the children, and only the children, rate the unpleasant pictures less arousing than the pleasant pictures.

Table 5. Normative arousal ratings of affective pictures used in the present study.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	5.74	2.96	7.03	6.50	5.67	6.91
Adolescents	5.90	2.59	6.52	5.28	2.72	6.43
Adults	4.57	2.63	5.52	5.61	2.77	7.25

Ratings-Physiology Covariation Analysis

Covariation refers to the relationship affective judgments have to specific physiological responses. That is, affective ratings are hypothesized to covary with physiological measures of emotion. To investigate this, ratings on a given dimension were rank ordered within each subject, following Lang et al. (1993). After sorting each participants' ratings of slides, a rank is given to each slide from lowest (1) to highest (27) for each participant. On the arousal dimension, for example, the most arousing picture for each participant is given a rank of 27, the second most arousing picture receives a rank of 26, and so on. The specific picture ranked most arousing is likely to be different across subjects, but for each subject, their highest rated picture will get a rank of 27. Responses for subject's lowest and highest (and everything in between) ranked pictures are averaged for each age group and gender. This gives an average response at

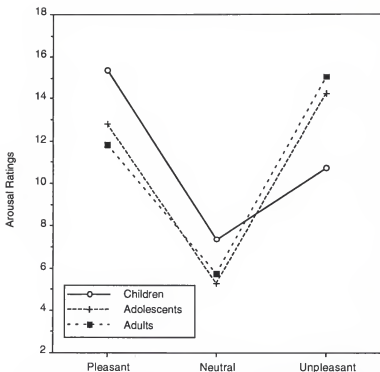


Figure 10. Mean arousal rating for picture valence categories by age group.

different levels (1 through 27) of the affective dimension (pleasure or arousal). A mean rating for each rank is also computed. Getting the mean rating for each rank keeps the ratio properties of the scale. The mean physiological response is then plotted by the mean rating for each rank (27 pairs of numbers). The highest rank for each participant, therefore, will coincide with the highest rating on the specific dimension and should coincide with the largest physiological response. The physiological response can then be ordered along increasing levels of the affective dimension and changes in the magnitude of the response can be seen.

Corrugator Activity

Figure 11 represent the increase in corrugator activity as pleasure ratings increase. The pleasure rating is the mean pleasure rating for each rank. Each line is the regression line and the correlation coefficient between the corrugator response and pleasure ratings appears in the legend for both genders at each age level. As expected, corrugator muscle activity decreases for males and females in all three age groups as pleasure increases. This relationship is statistically significant ($p < .05$) for all age and gender groups except male children. There were 11 children (out of 30) who had significant negative within subject correlations ($r \Rightarrow .38$), 9 adolescents (out of 30), and 11 young adults (out of 30).

Skin Conductance

As found in previous studies using college undergraduates (Lang et al., 1993), there is an increase in skin conductance as rated arousal increases. Figure 12 displays the relationship for each gender and age group. The increase in skin conductance is significantly ($p < .05$) related to increases in arousal ratings for females at each age level and approaches significance for adolescent males ($p < .07$). Only one child, no adolescents, and 1 adult had a significant ($r \Rightarrow .38$) within subject correlation between rated arousal and changes in skin conductance.

Heart Rate

There was little relationship between heart rate and either rated pleasure or arousal. The relationship with pleasure is shown in figure 13. When analyzed by gender and age group, only adolescent females show a significant effect, $F(1,25) = 12.19$; $p < .01$, but children and adolescents of both genders

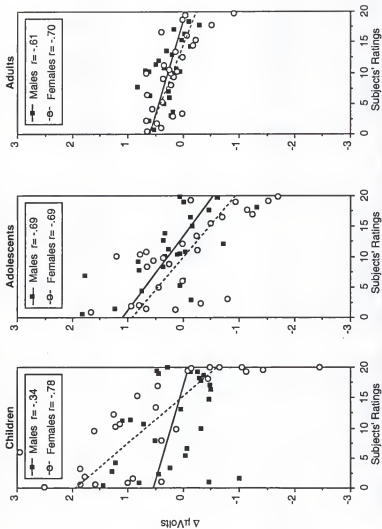


Figure 11. The relationship between changes in corrugator activity and subjects' own pleasure ratings.

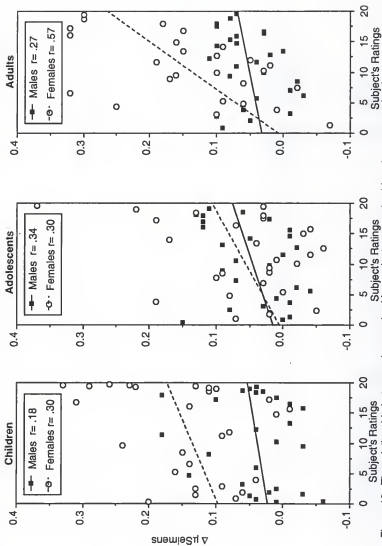


Figure 12. The relationship between changes in skin conductance and subjects' own arousal ratings.

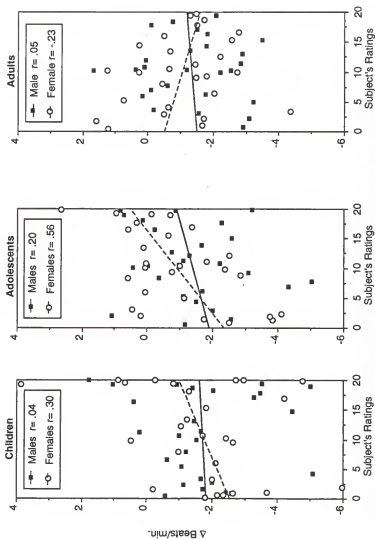


Figure 13. The relationship between changes in heart rate and subjects' own pleasure ratings.

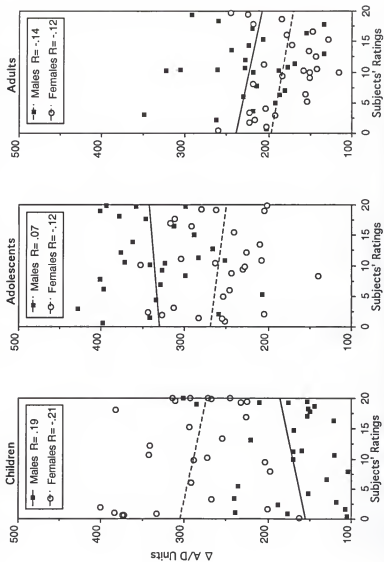


Figure 14. The relationship between startle magnitude and subject's own pleasure ratings.

show an upward trend, indicating that as pictures become unpleasant, heart rate deceleration increases. This relationship does not appear when looking at data from the adults participating in this study, but has been seen in a number of other studies (Greenwald et al., 1989; Lang et al., 1990; Lang et al., 1993).

Startle Magnitude

No age group showed a significant relationship between rated pleasure and startle magnitude. Looking at figure 14, however, some interesting points should be noted. In children, males and females show opposite relationships between rated pleasure and startle magnitude. By adolescence, this gender difference has decreased, and the young adult participants show no gender difference in their responses. What makes this more interesting is that females at all age levels show the expected negative relationship between startle magnitude and rated pleasure. Males, however, show a positive relationship in children, moving to a negative relationship in young adults.

Startle magnitude was related to arousal in adult women, but this may be due to the negative correlation this group had between pleasure and arousal ratings (see table 2). Baseline orbicularis oculi activity showed no relationship to pleasure or arousal.

Analysis of Physiological Responses by Affective Categories

Affective categories are based on normative ratings of slide valence. Each slide was classified as either pleasant, neutral, or unpleasant. The same slides fall into the same categories for each age and gender group. Responses, therefore, are to a given set of stimuli of a particular valence category.

Corrugator Activity

A MANOVA with sex and age group was done. There was a significant interaction between valence and gender, $F(2,83)=3.28$; $p=.04$, with females showing more modulation of facial EMG than males. Specifically, females,

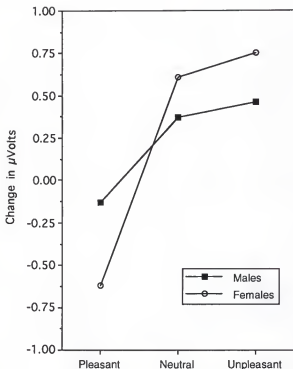


Figure 15. Gender differences in corrugator muscle activity while viewing pleasant, neutral, and unpleasant pictures.

when compared to males, showed less activity in the corrugator muscle when viewing pleasant pictures, as presented in figure 15. There was also a main effect, $F(2, 83)=19.34$; $p<.001$, for valence. There were no interactions with age group.

Independent MANOVAs were done separately for each age group. Statistically significant differences in corrugator activity while viewing

unpleasant versus pleasant pictures was obtained for all age groups (see figure 16a). Analysis of children's corrugator responses revealed a main effect for valence, $F(2,27)=10.91$; $p<.01$, and a significant interaction between valence and gender, $F(2,27)=3.63$; $p=.04$. As seen in table 6, both male and female children exhibited the same pattern of responding, but females showed greater modulation of the corrugator response. For adolescents, there was also significantly more corrugator activity while viewing unpleasant versus pleasant pictures, $F(2,27)=6.92$; $p<.01$. There was, however, no interaction between gender and picture valence. Finally, undergraduates also demonstrated affective modulation of their corrugator response, $F(2,27)=8.23$; $p<.01$, and as with adolescents there was no interaction between picture valence and gender in their corrugator response. All age groups showed differences in corrugator responses to pleasant versus unpleasant slides, but no differences between neutral and unpleasant, for both genders.

Table 6. Mean change in corrugator activity (in μ volts) during slide viewing for pleasant, neutral, and unpleasant pictures.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	-.16	.24	.50	-.91	1.10	1.50
Adolescents	-.26	.44	.52	-.78	.44	.32
Adults	.02	.43	.35	-.15	.28	.43

Skin Conductance

There was a significant main effect of picture valence, $F(2,83)=10.26$; $p<.01$, in skin conductance change. As with the covariation analysis, there was an increase in skin conductance associated with viewing unpleasant pictures.

There were no interactions between valence and gender or age group. There was, however, a significant gender effect, $F(1,84)=7.06$; $p=.01$, with females having larger skin conductance increases, relative to males, for all three valence categories.

Analysis of children's responses did not show a main effect for valence, but there was a significant main effect for gender, $F(1,28)=5.22$; $p=.02$. Table 7 indicates that females had higher skin conductance levels, overall. There was a significant main effect of valence for adolescents, $F(2,27)=3.74$; $p=.04$, as well as adults, $F(2,27)=5.70$; $p=.01$. There were no significant interactions for any age group. Figure 16b reveals the nature of the relationship between valence and skin conductance change, with adolescents and young adults showing greater increases in skin conductance for unpleasant slides relative to pleasant and neutral pictures. Children's skin conductance changed in the same direction as the other age groups, but the differences were not significant.

Table 7. Mean change in skin conductance (in μmhos) during slide viewing for pleasant, neutral, and unpleasant pictures.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	.05	.02	.05	.09	.13	.20
Adolescents	.03	.03	.08	.05	.05	.08
Adults	.03	.08	.11	.10	.11	.23

Heart Rate

There was a significant interaction between age group and picture valence, $F(2,83)=2.38$; $p=.05$. As seen in figure 16c, this is due to college undergraduates showing more heart rate deceleration to the pleasant slides while children and adolescents exhibit more deceleration to unpleasant slides.

There was a significant main effect of picture valence, $F(2,83)=4.70$; $p=.01$, with greater deceleration occurring in the context of unpleasant, compared to pleasant, pictures.

The test of the separate developmental groups helps to clarify the interaction between age group and valence. Independent MANOVAs for each age group. Analysis of children's heart rate revealed more deceleration to unpleasant material relative to pleasant material (linear trend), $F(1,28)=6.46$; $p=.02$. The adolescents show a similar pattern, with unpleasant slides showing significantly more deceleration than pleasant slides (linear trend), $F(1,28)=8.99$; $p=.01$. There was no significant effect of valence in heart rate for undergraduates. None of the age groups demonstrated any differences between genders.

Table 8. Mean change in heart rate (in beats per minute) during slide viewing for pleasant, neutral, and unpleasant pictures.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	-.80	-1.79	-2.55	-1.25	-1.54	-2.42
Adolescents	-.86	-1.42	-1.79	.09	-.76	-2.14
Adults	-1.68	-.98	-1.36	-1.33	-1.02	-.85

Startle Modulation

A multivariate analysis of the full sample revealed a marginally significant difference as a function of picture valence, $F(2,83)=3.08$; $p<.06$. The linear trend was significant, $F(1,84)=4.73$; $p<.04$, indicating that startles elicited while viewing unpleasant pictures were larger than startles elicited while subjects viewed pleasant pictures. There were no significant main effects for age or gender, nor any interactions with valence.

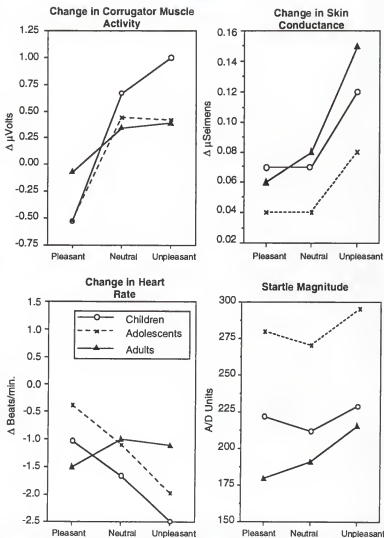


Figure 16. Psychophysiological measures for each valence category by age group.

Separate MANOVAs for each age group indicated no significant main effect for valence in any age group. However, the adults showed a significant linear effect of valence, $F(1,28)=5.78$; $p<.03$, and children had a significant interaction between gender and valence in the linear trend, $F(1,28)=4.87$; $p<.04$. The top row of table 9 reveals that while females in the youngest age group showed the expected relationship between valence and startle, males in this age group exhibited the opposite effect. This confirms the observations from the covariation analysis.

Table 9. Startle magnitude (A/D units) during slide viewing for pleasant, neutral, and unpleasant pictures.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	188.0	163.3	152.8	274.2	278.3	310.7
Adolescents	339.9	315.6	333.7	251.4	241.9	262.1
Adults	195.9	233.1	234.9	184.8	158.9	203.1

Baseline orbicularis oculi activity

Baseline levels of orbicularis oculi EMG activity were analyzed using a MANOVA, as well. Table 10 gives the mean baseline levels, which reveal that adults showed much less baseline activity across gender and picture valence, relative to children and adolescents. Notice that all male groups and adult females showed a quadratic pattern of orbicularis oculi activity. That is, EMG activity during viewing of pleasant and unpleasant pictures is greater, relative to neutral pictures. There was a significant linear effect of valence, $F(1,84)=10.07$; $p<.01$, with more activity during pleasant pictures. There was also a significant quadratic effect of valence, $F(1,84)=21.95$; $p<.001$, indicating muscle activity during both pleasant and unpleasant pictures was greater than activity during

neutral picture viewing. Females exhibited higher levels of orbicularis oculi activity, $F(1,84)=6.55$; $p<.02$, and children showed the highest levels of activity (see figure 17), $F(2,84)=7.07$; $p<.01$. The interaction between gender and age was also significant, $F(2,84)=3.86$; $p<.03$, with female children showing the highest level of activity. There were no interactions with valence.

Given the relationship between orbicularis oculi activity and picture valence, further analysis of the startle magnitude was conducted. Analysis of covariance (ANCOVA) was performed using the baseline EMG activity for pleasant, neutral, and unpleasant as separate covariates. The adjusted means for each age group are shown in figure 18. In this analysis, there was a significant effect of valence for the overall sample, $F(1,83)=6.51$; $p<.02$, indicating that the relationship between startle and picture valence was independent of the baseline differences. There was no effect for gender or age, and no interactions.

The two other measures derived from the startle response, onset latency and peak latency, showed no significant difference.

Table 10. Orbicularis oculi activity (A/D units) during slide viewing for pleasant, neutral, and unpleasant pictures.

Age Group	Males			Females		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Children	208.6	173.8	190.1	369.4	306.2	293.3
Adolescents	266.7	222.2	252.4	251.7	200.4	225.2
Adults	131.3	117.8	131.9	198.0	182.2	188.6

Viewing time

In studies with adult populations, viewing time has corresponded with arousal ratings, with pleasant and unpleasant pictures being looked at equally

long, but longer than neutral. In the present study, the quadratic trend, testing pleasant and unpleasant versus neutral, was significant, $F(1, 84) = 4.77$; $p = .03$, indicating that participants liked to look at both pleasant and unpleasant picture more than neutral pictures. Further investigation, however, reveals that it is unpleasant pictures that are looked at longer than both pleasant and neutral, significantly so for adults.

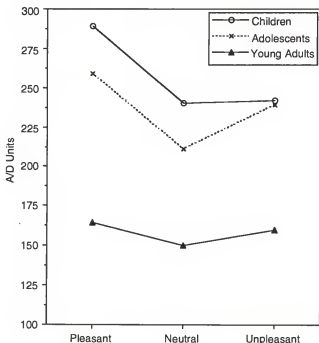


Figure 17. Baseline levels of orbicularis oculi activity while viewing pleasant, neutral, and unpleasant pictures.

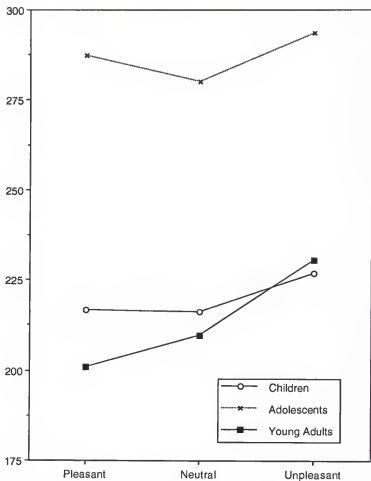


Figure 18. Startle magnitude adjusted for baseline orbicularis oculi activity prior to the startle probe.

When considering each age group separately, a significant gender difference, $F(1,28) = 11.12$; $p < .01$, was found in children, with females looking at the pictures significantly longer than males. There was no valence effect and no interactions. Adolescents showed no valence differences or any interactions. Young adults viewed unpleasant pictures longer than pleasant or neutral, $F(2,27) = 5.56$; $p = .01$. A post hoc analysis confirms this observation, $t(29) = 2.55$; $p < .02$. Table 10 gives the means for each age group. The bottom row of numbers gives the mean viewing time for undergraduates, and demonstrates that they looked at pleasant and unpleasant pictures longer relative to neutral pictures, $F(1, 28) = 5.16$; $p < .04$.

Table 11. Mean viewing time for pleasant, neutral, and unpleasant pictures.

<u>Age Group</u>	<u>Males</u>			<u>Females</u>		
	<u>Pleasant</u>	<u>Neutral</u>	<u>Unpleasant</u>	<u>Pleasant</u>	<u>Neutral</u>	<u>Unpleasant</u>
Children	4.00	3.55	4.08	5.78	5.31	5.44
Adolescents	4.65	4.27	5.80	5.32	5.63	5.41
Adults	5.18	4.60	6.04	4.80	4.77	5.23

DISCUSSION

This study was a first effort at extending to younger populations a methodology frequently used to study emotions in adults. Ratings on two emotional dimensions were found to be related to physiological and behavioral measures. Specifically, pleasure was related to corrugator EMG activity when examined with respect to either the subjects' own pleasure ratings or *a priori* valence classifications. Also, changes in skin conductance were related to subjects' own ratings of arousal, as expected. Heart rate was sensitive to picture valence when looked at by *a priori* categories, but not by subjects' own ratings. Startle magnitude was only a weak indicator of the affective content of pictures, but in the overall sample, startles elicited while participants viewed unpleasant pictures were larger than those elicited during viewing of pleasant pictures. There were interesting interactions between gender, age, and picture valence affecting the magnitude of the startle reflex. These are the issues that loom largest in the present study, indicating that the picture paradigm and startle probe may be useful in the investigation of emotional development and may be sensitive to gender difference in the development of emotional responding.

Looking across age groups, in one form or another, all of the measures reflected changes as a function of picture content. Utilizing *a priori* valence categorization, corrugator EMG, skin conductance change, heart rate, startle magnitude, baseline orbicularis oculi EMG, and viewing time all differentiated pleasant from unpleasant pictures. Baseline orbicularis oculi EMG and viewing time reflected differences due to the arousal associated with valence categories. These differences are consistent with Lang et al. (1993) and

support the idea that affective responses are fundamentally organized by the dimensions of pleasure and arousal.

Stimulus Selection, Categorization, and Judgments of Characteristics

It is a difficult task to find pictures that reliably elicit similar emotional states in children as young as seven years of age and adults in their twenties. While an effort was made to select stimuli that would work across the age range, affective judgments and physiological responses indicate that for some groups, especially male children, this effort was not successful. In previous research using college undergraduates, much more arousing affective material was used (Bradley, Lang, & Cuthbert, 1993; Cuthbert et al., in press; Lang et al., 1993; Simons & Zelson, 1985). Pleasant pictures used for adults include erotica and sexually explicit pictures. Unpleasant pictures include mutilated human faces and bodies, as well as disgusting pictures of filth and squalor. The school administrators who provided subjects for the standardization sample ruled that this material was outside the bounds of what is appropriate for children

Finding appropriate material clearly presents a problem for experiments involving affective modulation of the startle reflex. Cuthbert et al. (in press) show that strong affective modulation of the startle reflex is found only at high levels of arousal, and falls off rapidly as arousal diminishes. In order to compare how pictures used in the present study compare to pictures used in previous studies, table 11 shows the mean normative pleasure and arousal ratings for pleasant and unpleasant pictures used in the present study and in the moderate and high arousal pictures in the Cuthbert et al. (in press) study. This table shows that the pictures used in the present study are similar in pleasure and arousal to the pictures used for the moderate arousal set by Cuthbert et al. While the ratings of pleasure do not differ significantly, the ratings of arousal are significantly higher (one-tailed test) for the high arousal

set used by Cuthbert et al., $t(12) = -5.66$; $p < .001$, for pleasant pictures and $t(12) = -1.79$; $p < .05$, for unpleasant pictures.

Table 11. Mean pleasure and arousal ratings for pleasant and unpleasant pictures used in the present study and the moderate and high arousal pictures used in Cuthbert et al. (in press).

Picture Set	Pleasant		Unpleasant	
	Pleasure	Arousal	Pleasure	Arousal
Present Study	7.53	4.87	2.70	6.59
Moderate Arousal	7.50	5.54	2.73	6.30
High Arousal	7.64	6.93	2.16	7.07

Since the pictures used in the present study are not high in arousal, they did not generate high levels of arousal in subjects, as indicated by their ratings and skin conductance responses. As a result, there was less modulation of the physiological responses, producing low correlation coefficients. Corrugator activity is a notable exception, showing large changes in activity for pleasant and unpleasant pictures, as well as significant covariation between ratings and muscle activity.

On the other hand, the pictures used in this study were previously rated as more highly arousing by participants in a separate normative study than they were in the present study. It is not clear why children did not rate them as arousing in this study. One possibility is simply that these participants are different than those participating in the normative rating study. Another possibility is that the settings for the normative study and the present study were different. The normative study was conducted in a classroom with groups of children while the present study had individual subjects rate the pictures. Facial expressions are effective communicators of emotional state (Izard, 1991) and

children showed strong corrugator responses to the pictures in the present study. There are also a number of studies showing that children are sensitive to non-vocal verbal cues of emotion (Fernald, 1991; Fernald, 1993). The group setting, therefore, may have offered children with strong reactions to the affective pictures an opportunity to communicate their reactions, resulting in higher affective ratings for the pictures.

Adolescents and adults, however, rated the pictures in the present study in the same way as participants in the normative study. Children were also consistent across studies in their ratings of pleasure and dominance. It is only children's arousal ratings that were inconsistent. This issue is discussed further in the context of other emotional responses in the following section.

Development of Responses to Affective Pictures

The bio-informational approach sets forth three response systems that, taken together, describe the emotional response of the individual. The present study measured responses in each of these systems in order to determine if the picture paradigm is an effective method of investigating emotional development. When measures for each age group are looked at in terms of a complete system, it indicates that the picture viewing paradigm is, indeed, a useful method of investigating emotional development. Issues regarding gender differences that arise from this investigation also become clear as each age group is considered separately. Age and gender interact with picture valence in a complex pattern of affective responding within this paradigm.

Children's Responses to Affective Pictures

Looking first at children's affective judgments of emotional pictures, it is clear that the stimuli in this study did not get the expected ratings. Particularly, the unpleasant pictures were not rated as high in arousal as expected, given the data from the normative study. While unexpected, there are a few possible

explanations. First, since the ratings in the present study are based on a relatively small number of subjects. The ratings in this study may simply reflect normal variance in ratings, with a small sample giving low arousal ratings to these particular pictures.

Alternatively, it may be that, unlike adults, SAM as represented on the computer is different for children than the paper-and-pencil version used in the normative study. Specifically, the arousal dimension on the computer involves a picture of SAM that stands still with eyes closed at the lowest point, and as rated arousal increases, the figure's eyes begin to open and there is movement in it's center. Beyond the half way point of the scale, SAM's eyes are fully open, the movement in the center increases, and the figure begins to jump up and down on the screen. At the highest rating, the figure is jumping up and down rapidly and there is a great deal of movement in it's center. That is, there are two sources of animation that increase as ratings increase in the arousal rating used on the computer: SAM jumps up and down and there is activity in SAM's midsection. This active figure is very different than the motionless version used in the normative study (see figure 1). This difference could account for the differences in judgments found between the two studies.

Looking at children's physiological and behavioral responses as a function of arousal, it is not clear that for male children, the unpleasant pictures elicited the anticipated response. There is little change in skin conductance or viewing time when male children viewed unpleasant pictures, and the startle responses to probes during unpleasant pictures were not as expected. However, heart rate, corrugator, and baseline orbicularis oculi activity showed change related to unpleasant pictures. Female children show physiological responses consistent with unpleasant and arousing pictures, but also rated the unpleasant pictures lower in arousal than did their peers in the normative study.

The present study does not have the same subjects using both ratings methods and therefore cannot resolve this issue. However, as will be discussed in a later section, this issue can be resolved in future studies.

Physiological responses of children reflect varying levels of consistency across genders with affective ratings, as well. The consistent gender difference is always in favor of female children showing greater modulation in the predicted direction. Changes in corrugator muscle activity covaried with ratings of pleasure for female children, but not for males. Female, but not male children, also showed a relationship between rated arousal and skin conductance. While heart rate and startle magnitude were not related to children's pleasure ratings, other relationships emerged when *a priori* valence categories, based on normative ratings were used to organize the stimuli.

There was significantly more heart rate deceleration during viewing of unpleasant pictures, relative to pleasant pictures for both male and female children. There was an interaction between gender and picture valence for startle magnitude and changes in corrugator muscle activity, however. For corrugator activity, the pattern was the same for both genders, but female children showed greater modulation of their responses. For startle magnitude, the relationship was more complex. Females showed greater startle magnitude when eyeblinks were elicited while viewing unpleasant pictures versus pleasant pictures. Males, conversely, showed inhibition of the startle response while viewing unpleasant versus pleasant pictures.

Gender differences found in the present study are consistent with differences in other areas of emotional development. For example, Saarni (1984) has shown that female children are better at understanding the use of display rules regulating the expression of emotion. This is attributed to their higher levels of empathy. Zahn-Waxler, Cole, & Barret (1991) review the

evidence showing that girls are better than boys at understanding the emotions felt by others. Also, Boyatzis, Chazan, & Ting (1993) used pictures of facial expressions and found that preschool girls were better than their male peers at recognizing facial expressions. This pattern of females being better than males at a variety of emotional tasks is consistent with the results from the children in this study. Female children may be better at processing the emotional aspects of the pictures. Gender differences often found in the development of emotion may be due to differences in the socialization of emotion. For example, Fivush (1991) has found that mothers discuss emotional events differently with their preschool sons and daughters. Mothers emphasized sadness more with daughters and anger more with their sons, indicating that boys and girls are socialized differently to respond to emotional stimuli. In the context of this study, many of the pictures involved people and greater empathy found in females may improve their ability to respond emotionally to the stimuli. That is, in a six second viewing period, girls may be better able to empathize with the people in the pictures, increasing their emotional responses.

Adolescents' Responses to Affective Pictures

Unlike children's ratings, affective ratings by adolescents were consistent from the normative study to the laboratory study. Their ratings were also consistent with their corrugator activity while viewing pictures, with lower pleasure ratings corresponding to higher corrugator activity. Lower pleasure ratings were also related to heart rate deceleration in females, with males showing a nonsignificant trend in the same direction as the females. Higher arousal ratings were significantly related to larger increases in skin conductance for males and marginally so for females. Thus, for adolescents, ratings and physiological measures were generally related.

When looking at *a priori* valence categories, similar relationships as those using participants own ratings were found. That is, increased corrugator activity and greater heart rate deceleration for unpleasant pictures. For skin conductance, there were greater increases while adolescents viewed unpleasant versus pleasant and neutral pictures. This is different from what was expected based on research with college undergraduates, where responses to pleasant and unpleasant pictures are not different from each other, but both are different from neutral. A possible reason for this can be found in recent data using college undergraduates (Lang, Bradley, Drobles, & Cuthbert, 1995). A study using different semantic categories of pleasant, neutral, and unpleasant pictures has shown that, in college undergraduates at least, it is only the highest arousal contents (i.e., erotica) that shows large increases in skin conductance for pleasant pictures. Since there were no comparable stimuli in this study, this could reduce the effect.

There is little evidence of affective modulation of the startle response in adolescents. Again looking to studies with adult populations, an explanation for this can be found. Cuthbert et al. (in press) found that there is an arousal threshold for startle modulation. That is, there is no affective modulation of the startle reflex at low to moderate levels of arousal, but as arousal continues to increase, there is increasing differentiation of the response elicited while viewing unpleasant versus pleasant pictures. Given that the pictures used in this study do not represent the extremes in valence and arousal (see table 11) that are possible in the picture medium, the failure to see modulation of the startle response may be due to the stimuli used in this study.

Young Adults' responses to Affective Pictures

As with adolescents, young adults ratings were consistent from the normative study to the laboratory study. Adults demonstrated increased

corrugator activity as pleasure ratings increased, and greater skin conductance as arousal ratings increased. Females showed a stronger relationship between skin conductance and arousal, but males showed a relationship in the same direction.

Looking at *a priori* valence categories, three results stand out as unanticipated. While corrugator activity viewing unpleasant pictures was greater than that during pleasant pictures, it was not greater for unpleasant versus neutral. Indeed, looking at the range of change from baseline, it appears that the difference between pleasant and neutral/unpleasant is due to a decrease in activity while viewing pleasant pictures. The lack of an increase in corrugator activity for unpleasant pictures may be due to the specific pictures used in this study. The unpleasant pictures used in this study were less arousing (see table 11) than pictures typically shown to adult populations in this paradigm, thus, less modulation of affect measures could be expected.

Another unexpected finding was that heart rate deceleration was not greater during viewing of unpleasant versus pleasant pictures. This, too, appears to be a function of the affective characteristics of the specific pictures used in this study. Among unpleasant pictures, the highest arousing material shows more sustained heart rate deceleration (Lang et al., 1995). The limitations of the pictures due to the exclusion of erotic and other highly arousing material makes the adult heart rate inconsistent with previous studies.

As with adolescents, adults skin conductance showed an increase only to the unpleasant pictures. Previous studies using college undergraduates have shown skin conductance increases for both pleasant and unpleasant pictures if the picture content is sufficiently arousing (Cuthbert et al., in press; Cuthbert, Schupp, McManis, Hillman, Bradley, & Lang, 1995; Lang et al., 1995).

The lack of increase in skin conductance while viewing pleasant pictures is consistent with the idea that they were under arousing.

Looking Ahead

A number of issues raised by this study remain unresolved. Future studies need to address the issue of regarding the particular stimuli used in this study should be investigated. It may be that there is no set of affective pictures that can engage the appetitive and aversive motivational systems across a wide emotional age range. However, it is possible to find particular sets of stimuli for smaller age ranges that will elicit affective responses. There has been a great deal of attention recently paid to the sexual and violent content of television programs. Material similar in content to the television shows that have drawn the greatest complaints would be a good place to begin the effort of finding more intense stimuli, as it would help to resolve unstudied issues regarding the effects of these television programs on children.

The issue of arousal ratings in the laboratory versus the normative studies needs to be addressed directly in a study involving both paper-and-pencil and computerized versions of SAM to collect affective ratings of the pictures. Such a study gives the opportunity for a direct comparison of the two methods of affective ratings and allows for an evaluation of each presentation method.

Also of interest is the consistency of gender differences in children. This needs to be investigated, as well as the relationship between the methods used in the present study and other measures showing gender differences in emotional development. For example, empathy measures can be used to investigate the relationship between empathy and affective responses to pictures. Other emotional tasks could be used, as well. Facial expression recognition or the use of facial display rules could also be included in a study of

affective responses to pictures, in order to investigate the relationship between emotional tasks known to exhibit gender differences and emotional responses to affective pictures.

As these issues are resolved, the methods developed in the present study can be used to study a variety of emotional phenomena in children. For example, the affective modulation has been shown to be sensitive to temperamental differences (Bradley & Lang, 1992) and can differentiate clinical populations (Patrick, Cuthbert, & Lang, 1994) in adult populations. Additionally, the startle probe has been used to investigate the time course of affective picture processing (Bradley, Cuthbert, & Lang, 1993) and the development of anticipatory anxiety (Grillon, Ameli, Woods, Merikangas, & Davis, 1991). These are all areas of research that can be extended to children. A reliable measure of emotional state, such as those used in this study, would increase our understanding of emotional development and the development of emotional information processing.

To conclude, the results provide support for the use of the picture viewing paradigm in the study of emotional development. The difficulties inherent in finding appropriate stimuli could be greatly reduced by limiting the age range of the participants. There was rather weak correspondence between emotional dimensions and physiological responses. This is especially true of the arousal dimension. It is not clear at this time if the lack of concordance between skin conductance and arousal ratings is due to a lack of highly arousing pictures or due to a more fundamental difference in children's and adolescents' emotional responses. Future studies can and should address the issues raised in the present study.

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APPENDIX A

CHILDREN'S NORMATIVE SLIDE RATING STUDY

Summary

Pictures depicting various emotional scenes were shown to 123 elementary and middle school students and 20 college undergraduates. Each subject rated the pool of pictures using the Self-Assessment Mannequin (SAM), which measures pleasure, arousal, and dominance (Mehrabian & Russell 1974). For pleasure, words like happy, pleased, good, and unhappy, scared, angry, bad or sad were used in the instructions to describe the endpoints. For arousal, words like calm, relaxed, bored, sleepy and excited, nervous, or wide awake described the endpoints. For dominance, endpoint descriptors included feeling important, being a leader, and feeling unimportant or bullied.

The unlabeled dimensions were represented pictorially on a 9-point scale. Order of the dimensions on a page was randomized across trials. Subjects were run in groups of 8 to 25, depending upon each class size. Sessions were conducted in similar rooms (a classroom) under the same lighting conditions for each group.

Subjects viewed a warning/preparation slide for 5 seconds, then viewed each content picture for 6 seconds, immediately after which the ratings were made. The rating period varied from 15 to 20 seconds, allowing ample time for ratings.

There were 36 (18 females) young children ranging in age from 7-9 years. There were 47 (25 females) children ranging in age from 10 to 12 years.

There were 40 (17 female) adolescents (13-14 year olds). A control group consisted of 20 (10 female) college undergraduates, 18-23 years old.

Children showed a consistent pattern of higher arousal pictures being rated as more extreme on the pleasure dimension. That is, pictures rated highly arousing were also rated as more pleasant or more unpleasant than pictures rated low in arousal. This pattern is identical to that found previously with adults. All groups showed very high correlations (ranging from .96 to .99) between pleasure and dominance ratings, suggesting that these dimensions are redundant. There were significant correlations between the child and adolescent groups ratings on both pleasure and arousal dimensions and ratings from the adult undergraduate sample on these dimensions. Specifically, correlations between young children and undergraduates were .95 and .88 for pleasure and arousal, respectively. Similarly high correlations were obtained between older children and undergraduates (.96 for pleasure and .89 for arousal) and for adolescents and undergraduates (.96 for pleasure and .90 for arousal).

Coefficient alphas were computed for each age group. Results indicate a high degree of reliability (α ranging from .97 to .99 for the sample) in children's ratings of emotional pictures. These results indicate that children respond emotionally to pictures in a manner very similar to adults, and that the Self-Assessment Mannequin is a useful measure of children's feelings.

Ratings Instructions

Hi, we are from the University of Florida and we are here to show you some pictures. Today we will be doing an experiment. If you do not want to participate or if you think your parents might not want you to be in a research study you do not have to. Now, those who want to can follow us to the room where we will be doing the experiment and hear more about it. You can also

choose to not be in this study later, after you hear more about it. Anyone who does not want to go can stay here and continue working.

GO TO EXPERIMENT ROOM

We are here to show you some pictures. We need to know how you feel when you see these pictures so that we can learn more about children's feelings. You will see lots of slides showing different things that may make you feel happy or unhappy, excited or relaxed, or maybe even angry, scared, or thrilled. Every child will feel differently about each slide. There are no wrong answers. Whatever you feel is the right answer to put on the page. What we are doing today is very important. You need to listen carefully to the instructions so you will be able to fill everything out correctly. Also, during the slide show it is very important that you not talk or laugh or make comments to your classmates. If you talk, the experiment will be ruined and we will have to go back to the classroom. Does everyone understand? This is very important.

To help you tell us how you felt when you saw the slide, we are going to use SAM. You each have a page that has SAM on it. Is there anyone who doesn't have a copy of SAM, please hold up your hand? **(Pause)** SAM has helped lots of people tell us how they feel. OK, please turn the page so that you can see the number three, like this **(show correct side)**.

After you see each slide, you will be able to tell us how you felt when you looked at the slide by marking the picture of SAM that best shows how you felt. Again, there are no right or wrong answers. Just tell us how you felt when you saw the slide.

Looking at the page, you see that the first row has five pictures of SAM. Notice that on one side, SAM is frowning, on the other side, SAM is smiling, and in the middle, SAM is not smiling or frowning. These pictures are in order from a very unhappy SAM to a very happy SAM. **(Turn on slide projector)**.

Looking up at the screen, you can see that there is a big **X** on the picture of SAM that shows him smiling very big. This is where you would put a mark if the slide you had just seen made you feel happy, glad, cheerful, pleased, good, or hopeful. (**Adv. projector**) On this slide, there is an **X** on the picture of SAM frowning. This is where you would put your mark if you felt unhappy, scared, angry, bad, or sad. If you feel neutral, that is you, didn't feel either happy or unhappy, then you can put an **X** over the picture of SAM that is not smiling or frowning. (**Show with laser pointer**) (**Adv. projector**) If you felt in between being very happy and a little bit happy, you could put an **X** between pictures of SAM, like this.

Now let's look at the second feeling. This row shows pictures of SAM when SAM is very still and his eyes are closed. You would use this SAM if you felt very calm, relaxed, bored or sleepy. You would use the SAM on the other side of the row, if you felt very excited, nervous, jittery, active or wide awake on one side. Notice how it looks like SAM is jumping up and down and his stomach is excited. This is like when you get excited and can't sit still or like you have butterflies in your stomach when you are very nervous. Use this row to tell how excited or calm you felt when you saw the slide. (**Adv. projector**) If you are very excited, enthusiastic, nervous, scared, or wide awake you would put an **X** over here, like this. (**Adv. Projector**) If you feel calm, relaxed, or sleepy, place an **X** here, like this. (**Adv. projector**) Just like the first row, you can put an **X** between pictures like this. If you felt in between calm and sleepy and very excited, you could put an **X** between pictures of SAM, like this.

The third row shows SAM very little and getting bigger and bigger. Sometimes, you feel unimportant or out of control, bullied, like someone else is the leader or in charge, or like you can't handle the situation when you watch the slide. This is when he looks very small. Other times, you feel important or

very big or like you don't need anyone's help. This is when SAM looks very big. You can use this row to show how you felt when you saw the slide. (Adv. projector) If you felt grown up and able to handle the situation, then you would put an X on the big SAM, like this. (Adv. projector) If you felt more like you couldn't handle the situation and small then you would put an X on the little SAM, like this. (Adv. projector) You can also put an X in between pictures like this.

Now we will see some slides and practice using SAM to show how you felt. Each picture will be on the screen for a little while, and then another slide will come on telling you to rate the picture you just saw. When you see this slide, you should mark SAM to show how you felt when you were looking at the picture. Then, another slide will come on telling you that the next picture is coming up. I want to remind you that there are no right or wrong answers, just put down how you felt when you were looking at the slide. Also, please remember there is no talking. This includes no laughing or making sounds. We will have to stop the show if you make a lot of noise. If you have a question, raise your hand and we will come to you. You will have a chance to talk about the slides and your feelings after the experiment is over.

If you do not want to be in this experiment, you should leave now. Some children may not like to watch the pictures. If you feel that way now or at any time during the experiment, you can go back to the classroom.

(Go through demo slides)

Are there any questions?

Now look at your books. On the front, please put your name, your teacher's name, how old you are right now, and circle whether you are a boy or a girl.

(Begin slide show)

APPENDIX B

INSTRUCTIONS FOR SAM RATINGS IN LABORATORY EXPERIMENTS

In this part you will be rating emotions that you might be feeling. To do this, we will use this monitor (point to SAM display), and this joystick. This is SAM. We will use SAM to help you tell us how you felt when you were watching a picture. Just like before, a picture will come on the screen, but this time you will get to watch it for as long as you want. You should press this button on the joystick to turn it off. Then the SAM figure will come on like this and you will get to tell us how the picture made you feel.

(Place the joystick in the Subject's lap.)

When you see the message "Please Center the ratings knob" you need to move the joystick back and forth.

First, think how Happy vs. Unhappy the picture made you feel. If you move the joystick to the left, you can see the SAM is smiling. The further you move it, the bigger he smiles. If you move it the other way, SAM begins to frown. You can tell us how you felt while watching the slide by making SAM look the way you felt. If you felt very happy, glad, cheerful, pleased, good, or hopeful. If you only felt a little bit happy, you can make SAM smile just a little bit.

If you felt very unhappy, scared, angry, bored, or sad you can make SAM frown by moving the joystick all the way to the right. If you only felt a little bit

unhappy, you can make SAM frown just a little. You can make SAM smile or frown as much as you want to show us how you felt when you were looking at the slide. If you didn't feel happy or unhappy, you can make SAM's mouth a straight line. When you have SAM looking the way you felt, you press the button on the joy stick to record your answer. Then the next rating will come up.

Remember to move the joystick back and forth.

Now think about how Calm vs. Aroused the picture made you feel. If you felt very excited, like you couldn't sit still, like you have butterflies in your stomach, nervous or nervous, or wide awake you should move the joystick all the way to the right. You can see that SAM is jumping up and down and the dots are moving around alot. If you only felt a little bit excited, you can make SAM jump slower and the dots will move around slower.

If you felt very calm, relaxed, bored, or sleepy you can make SAM stop jumping and close his eyes. If you only felt a little bit calm, you can make SAM's eyes close just a little. If you didn't feel excited or calm, you can make SAM stand still with his eyes all the way open. You press the button on the joystick to record your answer and then the next rating will come on.

Now you need to move the joystick back and forth again.

Now think about how In control vs. Controlled the picture made you feel. If the picture made you feel important, very big, or in control of the situation, you can make SAM get very big. If you felt only a little bit important, you can make SAM a little big. If you felt unimportant, controlled, bullied, or like someone else is the

leader, you can make SAM get small. If you felt only a little bit controlled, you can make SAM only a little bit small.

After you press the button on the joystick here, you should look up at the screen for the next picture. Remember you can look at the picture as long as you like and then press the button on the joystick. Let's do another practice.

Let's do one last practice to make sure you can remember everything.

APPENDIX C
LABORATORY AND NORMATIVE RATINGS FOR PICTURES

<u>Slide</u>	<u>Description</u>
171	3 Puppies
175	2 Bunnies
192	Dolphins playing
292	Clown
548	Fireworks
733	Ice cream
741	M & Ms
849	Roller coaster
851	Red sports car
219	Neutral man
228	Neutral boy
232	Girl reading
700	Rolling pin
701	Wicker basket
709	Book
710	Fire hydrant
713	Truck
715	Umbrella
112	Snake ready to strike
128	Rat
130	Pit bull snarling
310	Burn victim
350	Man getting mugged on subway
353	Terrorist with gun in mouth
623	Aimed gun
630	Knife
637	Masked man

Children (7-10 yrs.) - Laboratory Ratings

Slide Number	Males			Females		
	Pleasure	Arousal	Dominance	Pleasure	Arousal	Dominance
292	13.87	11.40	13.87	17.67	15.20	17.27
849	16.00	16.27	14.47	18.40	17.20	13.93
733	16.80	16.20	18.13	18.40	13.33	11.07
175	17.53	11.93	16.60	19.07	15.67	19.13
548	17.67	14.93	16.80	19.53	17.13	15.33
192	18.33	15.20	16.67	19.80	14.67	18.00
851	18.33	16.00	16.93	20.00	17.40	17.80
741	18.53	15.53	16.33	20.00	15.93	17.20
171	18.60	15.20	17.07	20.00	17.33	18.93
232	7.33	5.60	9.40	9.07	5.87	13.73
219	8.33	4.87	7.93	9.20	7.47	8.33
709	8.33	5.87	8.20	10.87	6.73	13.47
715	8.47	4.47	9.80	11.13	8.40	12.20
228	10.20	8.20	12.20	11.20	8.33	8.27
701	10.33	7.13	9.27	11.67	7.40	14.73
700	10.53	5.73	10.53	11.73	6.87	14.07
710	12.00	9.53	13.27	12.80	7.93	12.53
713	13.53	11.73	14.73	15.33	10.20	12.27
350	2.27	7.00	2.33	0.20	9.33	2.73
630	3.07	7.60	5.67	0.73	11.73	2.60
353	3.47	8.27	4.33	1.00	12.20	2.07

310	3.60	7.33	4.80	1.87	11.27	3.20
623	4.33	12.20	4.60	2.20	11.93	2.53
637	4.47	8.60	4.20	2.87	12.47	4.07
130	6.07	12.67	6.80	4.07	10.47	5.47
128	9.33	9.33	10.60	4.27	14.80	4.13
112	11.53	12.47	11.40	4.87	13.33	3.47

Adolescents (12 - 15 yrs.) - Laboratory Ratings

Slide Number	Males			Females		
	Pleasure	Arousal	Dominance	Pleasure	Arousal	Dominance
292	12.40	8.13	10.40	13.93	10.13	12.60
741	15.53	15.27	10.93	14.87	13.20	14.80
733	16.00	10.93	14.53	15.80	13.73	16.47
851	16.40	9.27	13.27	16.47	13.20	14.73
175	16.53	10.93	12.53	17.13	12.60	14.73
849	16.67	9.93	15.07	17.47	17.07	9.53
548	16.93	12.33	13.53	17.67	14.40	13.60
192	17.13	14.73	18.20	17.87	14.80	13.80
171	17.73	13.53	11.87	18.53	15.93	13.87
228	7.60	2.13	11.00	8.87	6.07	10.47
219	8.47	7.67	11.13	8.87	5.47	9.53
713	8.53	7.07	10.40	9.00	7.60	7.80
701	8.60	8.13	11.40	9.40	4.40	13.53
700	9.27	2.93	13.47	9.60	5.80	12.87
715	9.73	3.80	11.93	9.80	6.27	14.33
709	9.80	4.80	12.60	10.53	7.27	13.13
710	9.80	2.20	13.80	11.20	4.00	12.47
232	10.00	2.93	13.27	11.60	5.87	11.53
310	1.13	12.60	6.13	1.53	12.47	2.13
350	5.73	12.20	7.93	2.40	15.20	1.93
630	6.40	15.73	7.33	3.00	15.53	3.33

353	6.60	10.87	12.07	3.33	14.07	1.60
637	7.53	13.87	10.53	3.80	15.07	3.07
623	7.60	14.73	8.27	4.13	15.20	2.60
112	7.87	15.40	9.00	4.67	15.73	3.53
128	10.20	15.80	11.27	4.73	12.60	7.53
130	11.93	14.33	10.67	5.60	15.07	3.60

Undergraduates (18 - 24 yrs.) - Laboratory Ratings

Slide Number	Males			Females		
	Pleasure	Arousal	Dominance	Pleasure	Arousal	Dominance
292	13.07	9.53	11.87	11.20	9.73	10.60
849	14.80	10.80	13.13	15.07	11.33	12.67
733	15.87	16.60	7.67	16.27	8.13	13.60
175	16.00	13.80	11.87	16.47	11.87	12.93
548	16.07	8.13	13.33	16.53	9.53	13.20
192	16.20	13.27	13.33	16.73	12.80	12.80
851	16.53	12.73	13.27	17.13	9.93	13.73
741	17.07	12.13	14.07	17.40	11.47	11.20
171	17.20	15.73	14.47	17.60	15.60	9.53
232	9.73	5.93	11.73	8.87	7.20	10.20
219	9.87	4.80	12.07	9.13	8.53	10.73
709	10.27	4.80	12.20	9.73	4.07	10.93
715	10.33	5.40	12.60	9.80	5.60	11.93
228	10.47	2.60	13.93	10.53	5.53	12.13
701	10.60	5.60	13.33	10.67	8.13	8.40
700	10.73	6.87	10.47	10.80	5.00	13.13
710	11.00	4.80	14.53	10.93	6.93	12.40
713	12.00	6.87	11.27	14.07	5.27	13.47
350	1.93	13.87	4.67	1.93	13.27	8.07
630	3.53	16.07	4.40	2.33	17.27	3.87
353	4.27	15.07	6.93	2.67	14.73	5.27

310	4.47	15.07	5.80	3.60	16.13	4.20
623	4.93	14.73	7.07	3.60	16.33	3.07
637	5.53	13.47	10.93	3.73	16.60	3.47
130	6.27	15.80	7.47	4.07	14.93	5.13
128	6.53	13.13	6.93	4.20	15.13	6.80
112	7.47	14.93	7.73	4.80	14.13	8.00

Normative Slide Ratings: Children (7-10 yrs. old)

Slide	Males		Females	
	Pleasure	Arousal	Pleasure	Arousal
112	4.48	6.87	3.96	6.85
128	5.13	5.35	4.93	5.41
130	5.04	7.17	3.52	7.41
171	8.70	4.91	8.85	5.78
175	8.48	5.52	8.56	5.26
192	8.52	5.91	8.93	7.04
219	5.91	2.91	5.67	2.22
228	5.91	3.04	5.04	1.96
232	5.91	2.96	6.37	2.26
292	7.52	4.13	8.19	6.74
350	3.09	7.04	1.89	7.41
353	2.48	7.39	1.22	7.59
548	8.17	5.91	8.63	6.70
623	3.74	7.87	2.15	7.48
630	2.35	8.00	1.93	7.67
637	4.41	6.57	3.12	5.50
700	6.26	2.73	5.63	2.07
701	5.57	3.22	5.82	2.15
709	6.00	2.96	5.74	2.33
710	5.96	2.61	5.70	2.30
713	5.77	3.32	5.65	2.31
715	6.13	2.91	5.41	2.15
733	8.26	6.26	8.82	6.26
741	8.44	5.09	8.67	5.44

849	8.39	7.09	8.67	7.93
851	7.96	6.87	8.19	7.37

Normative Slide Ratings: Adolescents (12 - 14)

Slide	Males		Females	
	Pleasure	Arousal	Pleasure	Arousal
112	4.51	6.19	2.84	6.24
128	4.16	5.19	3.40	5.48
130	3.76	6.97	2.84	6.28
171	7.70	5.84	8.28	4.88
175	7.35	5.38	7.92	4.28
192	7.60	6.32	8.12	5.20
219	5.08	2.89	4.88	2.72
228	5.33	3.50	4.92	3.12
232	5.43	2.54	5.88	3.24
292	6.62	4.78	6.52	4.40
350	4.14	6.00	2.12	6.33
353	2.78	7.19	1.60	6.56
548	6.78	5.43	8.24	5.44
623	2.97	7.56	2.08	7.00
630	3.54	6.89	2.08	7.08
637	3.60	6.19	2.68	6.48
700	4.73	2.11	4.96	2.00
701	5.16	1.84	5.25	2.04
709	4.51	1.87	5.28	3.32
710	5.35	2.76	5.40	2.84
713	5.24	3.16	4.96	2.83
715	5.08	2.68	4.92	2.32
733	7.76	5.87	7.48	5.16
741	7.08	5.16	6.72	4.92

849	7.95	7.81	8.40	7.48
851	7.81	6.46	7.68	5.80

Normative Slide Ratings: Undergraduates

Slide	Males		Females	
	Pleasure	Arousal	Pleasure	Arousal
112	4.73	6.60	3.00	7.20
128	4.40	4.48	3.16	5.24
130	4.06	6.90	3.41	6.70
171	8.02	5.53	8.59	5.31
175	7.89	4.21	8.59	4.02
192	7.83	4.21	7.94	4.31
219	4.73	2.27	4.90	2.50
228	4.00	2.13	4.80	3.00
232	5.75	3.25	5.80	2.50
292	6.13	2.38	7.20	4.40
350	2.50	6.80	1.94	7.16
353	2.10	6.80	1.51	6.80
548	7.37	5.55	7.69	5.41
623	2.73	7.10	2.06	7.56
630	3.30	6.37	1.94	6.84
637	3.24	6.28	2.20	6.58
700	4.93	2.73	5.06	2.15
701	4.95	1.55	4.57	3.22
709	4.95	2.30	5.44	2.92
710	5.29	3.08	5.20	2.73
713	4.79	3.54	4.75	3.20
715	4.76	2.66	4.69	2.56
733	7.29	4.54	7.96	5.54
741	6.80	4.24	7.00	4.84

849	6.85	6.25	7.44	6.97
851	7.62	5.44	7.11	4.59

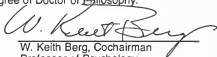
BIOGRAPHICAL SKETCH

Mark McManis received his Bachelor of Arts degree in psychology and his Master of Arts in general psychology, both from the University of West Florida. After graduation, he intends to pursue a career in academic teaching and research.

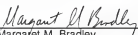
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Peter J. Lang, Chairman
Graduate Research Professor of
Psychology

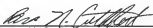
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W. Keith Berg, Cochairman
Professor of Psychology

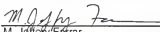
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Margaret M. Bradley
Associate Scientist of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Bruce N. Cuthbert
Associate Professor of Clinical and
Health Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


M. Jeffrey Farrar
Associate Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



James J. Algina
Professor of Foundations of
Education

This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1996

Dean, Graduate School

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